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East African Agricultural Research Institute

AMANI

Report for the years

1942-1945

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EAST AFRICAN AGRICULTURAL RESEARCH INSTITUTE*, *AMANI*

Report for the years 1942 *to* 1945

Compiled by the Acting Director

STAFF LIST AS AT 31st DECEMBER, 1945

Director, A. G. G. Hill, B.A., B.Agr., A.R.C.Sc.I. (*on leave*).

Plant Pathologist, H. H. Storey, M.A., Ph.D., F.R.S. (seconded to East African Industrial Research Board).

Entomologist, T. W. Kirkpatrick, M.A., Dip.Agr., F.R.E.S. (Acting Director).

Soil Chemist, D W. Duthie, M.A., B.Sc., Ph.D., F.I.C.

Biochemist, R. R. le G. Worsley, A.R.C.S., B.Sc., Ph.D. (seconded to Veterinary Research Laboratory, Kenya).

Plant Physiologist (1), F. J. Nutman, D.Sc., D.I.C. (seconded to Tanganyika Fibre Board Factory).

Plant Physiologist (2), J. Glover, M.Sc. (Botany).

Geneticist (vacant).

Botanist, P. J. Greenway, F.L.S.

Assistant Plant Pathologist, R. F. W. Nichols.

Assistant Soil Chemist (vacant).

Secretary and Librarian, R. E. Moreau, C.M.Z.S.

Assistant Secretary and Librarian (vacant).

Temporary Clerical Assistant, Mrs. L. Goldstucker.

Superintendent of Plantations, L. M. Fernie.

Assistant Superintendent of Plantations, C. B. Gibbons (serving with Forces).

Temporary Assistant Superintendent of Plantations, F. King-Smith.

Engineer, T. V. Greenwood.

* *Known as the East African Agricultural Research Station prior to* 1944.

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INTRODUCTION

No Annual Report has been published since that for the year 1941. This was necessitated partly by the paper shortage and partly by the fact that some of the investigations undertaken during the war years were regarded as secret. The present report therefore covers the four years 1942 to 1945: it has been compiled mainly from the sectional reports written by members of the staff, from which extracts have been freely quoted.

If this report contains little that can strictly be considered agricultural research, it must be remembered that the scientific staff, which in pre-war years was scarcely more than a skeleton one, was very seriously depleted during the war. The staff position, from the establishment of the present Institute in 1927 until the end of 1945, is shown diagrammatically on page 4. Nevertheless, although during these four years priority was given to *ad hoc* problems in connection with the war, a considerable amount of useful work has been accomplished.

PUBLICATIONS

It was only to be expected that the number of scientific papers written by the Amani staff would show a decline during the war years, as is evident from Table I.

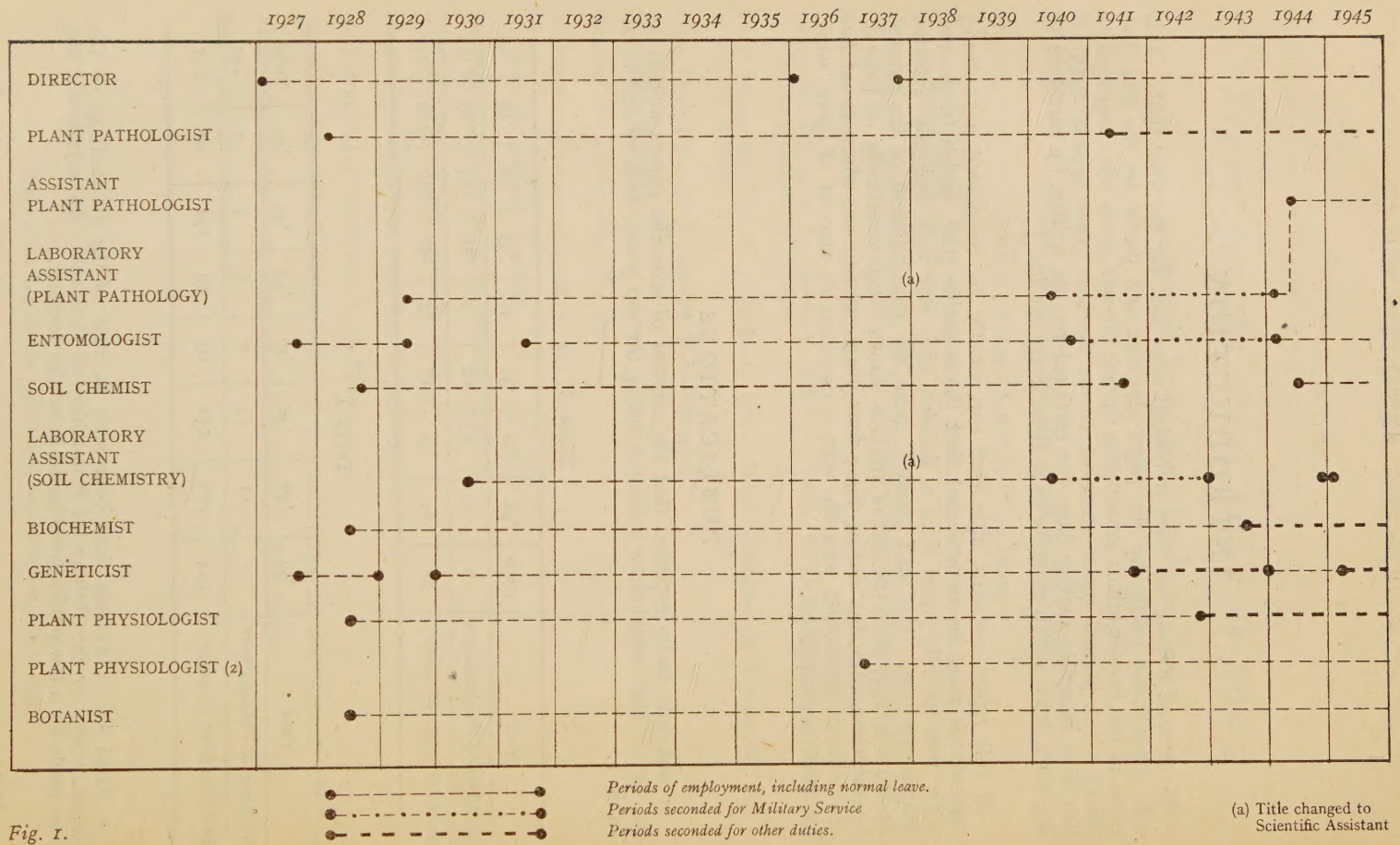
TABLE I

Year	1930	'31	'32	'33	'34	'35	'36	'37	'38
Number of Publications	3	2	3	10	5	16	13	26	13
Total number of pages*	51	24	33	342	83	240	216	469	199

TABLE I

Year	'39	'40	'41	'42	'43	'44	'45	Total
Number of Publications	7	11	13	9	3	7	4	145
Total number of pages*	132	186	142	63	39	131	91	2,441

* Based on an average-sized page such as that of the Proceedings of the Royal Society or the Bulletin of Entomological Research. An adjustment has been made for a few publications issued in smaller formats.


1927
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1944
1945
DIRECTOR
PLANT PATHOLOGIST
ASSISTANT PLANT PATHOLOGIST
LABORATORY ASSISTANT (PLANT PATHOLOGY)
(a)
ENTOMOLOGIST
SOIL CHEMIST
LABORATORY ASSISTANT (SOIL CHEMISTRY)
(a)
BIOCHEMIST
GENETICIST
PLANT PHYSIOLOGIST
PLANT PHYSIOLOGIST (2)
BOTANIST
Periods of employment, including normal leave.
Periods seconded for Military Service
Periods seconded for other duties.
(a) Title changed to Scientific Assistant

Fig. 1.

Table II gives a classification, by subjects, of all the papers published up to the end of 1945.

TABLE II

Subject	Number of Publications	Total number of pages
Plant Pathology	18	226
Entomology	12	258
General Zoology	3	96
Ecology and Climate	6	165
Ornithology	32	753
Soil Chemistry	16	247
Biochemistry	10	147
Plant Physiology	16	213
Genetics	2	27
Botany	10	195
General Agriculture	13	89
Miscellaneous	7	25
Total	145	2,441

A list of publications is given in Appendix B.

LIBRARY AND BIBLIOGRAPHICAL WORK

R. E. MOREAU, Secretary and Librarian, reports as follows:—" During the war the growth of the library was well maintained. Only a very small percentage of incoming publications was lost through enemy action. In the absence of an Assistant Secretary and Librarian there was a good deal of difficulty in keeping the routine work up to date, but the position was eased by the appointment in 1945 of Mrs. L. Goldstucker as temporary clerical assistant. Every effort is being made to resume our exchange relations with those numerous correspondents all over the world with whom they had to be suspended during the war ". (R.E.M.).

As a result of various enquiries R. E. Moreau undertook the following bibliographical studies:—

(1) An investigation of the localities and climates in which potatoes (*Solanum tuberosum*) are grown in East Africa broadened into a study of the results of potato growing in other tropical countries and into the basis of the commonly accepted idea that the potato is a " long-day " plant from which good yields cannot be expected under the " short-day " conditions of the tropics. The results of the study, which were thoroughly heterodox, have been published in the Empire Journal of Experimental Agriculture and in the East African Agricultural Journal. They do not seem to have been controverted.

(2) The importance of East Africa as practically the only source of high-grade derris after the fall of Java and Malaya made it desirable to compare the conditions in which it is grown in East Africa with those in the older producing countries and to collate the information available from experimental work there. Eventually a comprehensive bibliography of derris agronomy and on this basis a critical review were published in the East African Agricultural Journal. It is evident that the success attained in growing derris in East Africa is much greater than would have been expected from a comparative climatic study; also that there is scope for a very wide range of experimental work on the crop, the more so because so much of the published information is unsatisfactory or inconclusive.

(3) The plans for the extension of cinchona growing in the Colonial Empire called for a comprehensive bibliography, those already available in published form being very incomplete. The Amani library was especially well equipped with cinchona literature, probably better than any institution in United Kingdom or the United States of America, because of the interest taken in the subject at Amani since the station was opened by the Germans in 1902. Eventually the bibliography took the form of a special East African Agricultural Research Institute publication covering the period 1883 (when Moens' great work *Kinacultuur in Azië* may be said to have initiated the scientific literature of cinchona growing) to 1943, with 675 references, and annotations giving, where necessary, some indication of the contents.

A summary of cinchona-growing enterprise in Africa in the last hundred years has also been prepared which it is hoped to publish in collaboration with L. R. Doughty.

It would have been impossible for these studies to have been done with their eventual degree of completeness without the generous assistance that was given by several other institutions, among which special mention must be made of the Science Library and the United States Department of Agriculture.

EAST AFRICAN AGRICULTURAL JOURNAL

This publication continues to be edited by the Director of Amani. The arduous duties of Assistant Editor are normally undertaken by the Secretary, R. E. Moreau, for whom, during his absence on leave during 1945, D. W. Duthie deputised. The standard has been well maintained as regards quality, though recently there has been some falling off in the quantity of articles submitted for publication.

During the past four years 11 per cent. of the original matter appearing in the Journal has been contributed by the depleted Amani staff: this is a higher proportion than that from any other Department except the Kenya Department of Agriculture, which contributed 15 per cent. Consideration is being given to various measures for increasing the circulation. Although this has been on the up-grade the number of subscribers, especially in Kenya, is still far short of what it should be.

PLANT PATHOLOGY

Throughout the four years under review H. H. Storey* was seconded firstly as Scientific Secretary to the East African Supplies Board, subsequently in charge of the Research Branch of the East African Industrial Research and Development Board, and finally as Chairman of the East African Industrial Research Board. He was therefore able to do little at Amani except to pay occasional short visits to maintain contact with the work on testing virus-resistant strains of Cassava, which was continued under the supervision of F. M. Rogers, and later of L. R. Doughty, until the return from military service of the Assistant Plant Patholgist, R. F. W. Nichols, in 1944. The Amani collection of Cassava was maintained in good order and a limited programme of new hybridization was undertaken. Experiments were mainly devoted to eliminating the least desirable of the very large number of hybrids. At the end of 1943 H. H. Storey summarised the position of Cassava breeding as follows:—

> " One of the 1937 Cassava × Cassava crosses has continued to resist infection by mosaic viruses and is undoubtedly the most resistant type of true Cassava we possess. The policy of inter-specific hybridization and back-crossing has produced a great number of forms showing apparently high resistance to both groups of viruses but relatively few with desirable cultural qualities. Some of the existing forms may prove suitable for issue to cultivators; and on any reasonable forecast the development of economic types resistant to both diseases should not be long delayed once an officer can devote his whole time to the work." (H.H.S.).

R. F. W. Nichols was released from the Army in March, 1944. The following are extracts from his reports for 1944 and 1945.

Cassava.—" A considerable number of clones of both pure Cassava and inter-specific hybrids have been produced since the work began in 1937. Field trials for resistance to mosaic and brown streak viruses have been carried out at Kizugu each year, in spite of which there has been an accumulation of material awaiting test. The production of new clones has outrun the available land. It was obvious therefore that if the work was

* Early in 1946 Dr. H. H. Storey was elected a Fellow of the Royal Society in recognition of his work on virus diseases of plants.

to be accelerated more land had to be found, both for propagation and maintenance at Amani, and for field resistance trials in an area with a known high infection rate. A suitable site for the former purpose was found near the existing maintenance plot. Through the courtesy of the Sisal Growers' Association, to whom our thanks are due, 15 acres of land at the Sisal Experiment Station, Mlingano, have been placed at our disposal for field resistance trials.

" From results so far studied it is abundantly clear that a steady increase in resistance to the local strains of virus has been built up, though this does not imply that all such clones will prove equally resistant in other parts of East Africa. In three different replicated trials at Kizugu the variety 37244E was not infected by mosaic and was the only pure Cassava variety that remained entirely unaffected; but during the current year it has been naturally infected in Uganda and the Belgian Congo. Nevertheless its high resistance relative to other varieties in Uganda was fully evident.

" Of the Cassava × Cassava crosses several clones of varying high resistance now exist. At the conclusion of the current breeding season these will be multiplied for distribution and trial by Departments of Agriculture in a range of different localities.

" The F_3 generation has been reached in the hybridization of Cassava × ' Tree ' Cassava; Cassava × Ceara; and Cassava × *Manihot dichotoma*. The majority of these await field trials but of those clones tested a proportion in all three classes show high resistance to one or both viruses (which *may* in certain individuals prove to be immunity). The root systems of these plants are variable, some continue to be woody like the F_2 generation while others show a pronounced tendency towards becoming tuberous; the indications of ultimate success are encouraging.

" Over 2,700 seeds were harvested during 1945 from controlled crosses. Of this number about 1,000 seeds were from inter-varietal crosses between the more resistant true Cassava varieties. These were done at the request of Departments of Agriculture and the seed has been distributed for propagation and trial by the departments concerned. Should any of the progeny prove more resistant than, and generally superior to, varieties in cultivation they will no doubt replace the latter and tide over the period which must elapse before inter-specific hybrid material becomes available for general distribution. The remainder of the seed consisted mainly of back crosses to Cassava from a selection of F_2 hybrids between true Cassava and *Manihot dichotoma, Manihot glaziovii,* and ' Tree ' Cassava. Seedlings have been raised and the material will be multiplied as rapidly as possible for field trials. In addition to some selected Cassava × Cassava crosses the current season's breeding programme will be confined to raising a further batch of F_3 hybrids. The production of an F_4 generation must await the results of the current field resistance trials, which will be concluded about the middle of the year. the policy of propagating seeds resulting from open pollination has been discontinued since the hybrid material is now sufficiently fertile to ensure raising successive generations.

" It would be unwise to attempt to forecast the number of generations of back crosses required before these hybrids produce adequate root systems. There are indications, however, that some of the F_3 ' Tree ' Cassava series now undergoing field trial may produce satisfactory ' tubers ' without further back crossing. Admittedly the fibre content may be high. Should their performance for disease resistance prove to be satisfactory they should be tried

in other parts of the country to test their reaction to differing conditions. There seems to be little doubt also that back crosses from the hybrids with the other two species will eventually give plants with tuberous root systems comparable with true Cassava. A sample of true Cassava flour together with two samples from F_3 hybrid 'tubers' were sent to the Government Analyst, Dar-es-Salaam, for analysis. The figures for the hybrid samples compared very favourably with those obtained for true Cassava.

"The field resistance trials at Kizugu were harvested in September, 1945. Control clones indicated that natural infection was high. Of the 80 clones tested in the series of replicated trials 21 clones were retained on the basis of their resistance to mosaic. Although eight of these varieties (consisting of 6 *Manihot dichotoma* hybrids, 1 Ceara hybrid, and 1 true Cassava clone) came through the trial without a single plant being infected, there was no statistically significant difference between them and the other 13 retained clones, in which some infection took place. The figures for resistance to brown streak are 19 clones with no infections (5 *Manihot dichotoma*, 10 Ceara and 4 'Tree' Cassava hybrids), with no less than 38 clones falling into the 'no significant difference' group. Four hundred and forty clones were given a preliminary eliminating trial, as a result of which 140 have been retained for further testing in replicated trials. The soil on which these trials were conducted has been planted with Cassava for six years in succession and it is now practically exhausted. Elephant grass has been planted on it and the land will now be rested for three or four years.

"The first series of trials on the Mlingano plot were started in November, 1945, after 4½ inches of rain had fallen. They consist of three replicated trials on a randomised-block layout carrying a total of 180 varieties. Planting of preliminary elimination trials had to be deferred for lack of further rain. If rain falls early in 1946 the latter trials will be started. If, however, the rains break late the peak infection period will be past and it would be futile to plant until the following season. The drought at the time of writing (February, 1946) is so bad that a high percentage of misses must be expected in the trials already planted.

"Varieties awaiting trial, which accumulated during the war years, have now either been through field trials or are on test at present. In future it will be possible to put new varieties through field trials as they are produced.

"The new propagation plot at Amani, cleared and planted in 1944, has had to be abandoned on account of a serious outbreak of *Armillaria* root disease. The shortage of suitable land in the immediate vicinity necessitates going further afield. An area of about 10 acres, five miles away on Kwamkoro estate, has been made available and is now being prepared for planting in the long rains. For convenience during the pollinating season all varieties will be concentrated on this site.

"Future breeding work will be concentrated mainly on further back-crossing of the inter-specific hybrid material. Immunity tests by grafting technique will be carried out on those clones which resist natural infection in the field. The primary consideration must, of course, continue to be resistance to the two virus diseases, but since a wide range of types is now available the time has come when other factors can be taken into account concurrently. In order to obtain as many opinions as possible on the types of plants required under the wide range of conditions in different parts of East Africa a

questionnaire has been drawn up and circulated to Departments of Agriculture. The answers will be a useful guide in future.

" A general account of Cassava breeding and selection with the results obtained to date is in preparation and will be published in an early issue of the East African Agricultural Journal." (R.F.W.N.)

Virus disease of Sweet Potatoes.

The report by Mr. C. G. Hansford, Senior Plant Pathologist, Uganda, of a new virus disease of sweet potato in East Africa (East African Agricultural Journal 10 (2), page 126) led to a promise of co-operation by Amani in the investigation of this disease, but pressure of other work has resulted in little progress having been so far made. " The assumption that the disease was caused by a virus has, however, been confirmed. An experiment demonstrated that the disease occuring in this district is graft transmissible and it can therefore be regarded as a virus disease. In this locality symptoms are generally confined to a transient type of mild mosaic mottling whereas the symtoms recorded in parts of Uganda and in the Belgian Congo are of a more severe nature. Future work may show that differences in symptom expression are due to the existence of different strains of the same virus or to entirely unrelated viruses.

" Attempts to discover the insect vector have so far been unsuccessful. Apart from White-flies, likely vectors are rarely found on plants in Tanga Province (in which Amani is situated). Two experiments with White-fly gave inconclusive results. In the first experiment groups of insects collected on sweet potatoes in the field were confined in small glass tubes in which the tips of healthy shoots were exposed. The rate of growth of the shoots was so rapid that the tubes had to be removed after two days when the majority of insects were found to be dead. No infection resulted. In the past, difficulties in experiments with White-fly were encountered in studying the transmission of mosaic and brown streak diseases of Cassava. For some inexplicable reason these insects appear to be intolerant of sudden changes in altitude. When they are collected on the plains and brought up to Amani (a change in altitude of over 2,000 ft.) a large proportion die within a few hours. Insects bred at Amani, however, survive the conditions of experimentation reasonably well. The second experiment, on less exact lines, was designed to allow the insects complete freedom of movement. Twenty-four diseased plants from eight different varieties were placed in a greenhouse and White-fly introduced and allowed to breed. When the White-flies had become sufficiently numerous forty-two healthy plants from nine seedling clones were put into the chamber. Unfortunately the experiment was vitiated by the outbreak of a heavy Red Spider infestation augmented by a species of Thrips and all the plants were completely defoliated before they had made much growth. This occurred during one of my periods of absence from the station and it is not known if the test plants showed any disease symptoms before they became defoliated. Cuttings from these plants were treated in a strong nicotine-soap solution prior to replanting but this treatment proved too drastic and the majority of cuttings failed to root. Of the few survivors one plant produced a faint transient mottle on a few of its young leaves. The results were therefore recorded as inconclusive.

" More greenhouse space is now available and an intensive search for the vector will be prosecuted during 1946. Healthy clones have been raised from true seed and maintained in the greenhouse. By vegetation propagation a continuous supply of healthy material is thus avaliable as required." (R.F.W.N.)

ENTOMOLOGY

Entomological work was completely in abeyance during 1942 and 1943, as the only Entomologist, T. W. Kirkpatrick, was serving with the Royal Air Force. On his return to Amani early in 1944 he undertook, at the request of the Provision Office of the East African Command, an investigation into the damage caused by wood-boring insects to East African timbers. It had been reported from overseas that a consignment of railway sleepers from East Africa showed very heavy damage by borers, a large proportion of them being unfit for use. He inspected the timber yards at Mombasa, Tanga and Dar-es-Salaam and also visited a number of sawmills in Kenya and Uganda. Most of the serious damage was being caused by Bostrichidae and a little by Lyctidae. Injury by Buprestidae and Cerambycidae and "pin-hole" damage by Scolytidae and Platypodidae was frequently observed but was of minor importance compared with the losses being caused by Bostrichidae. In many instances Bostrichid infestation was present in up-country sawmills and timber yards, but the really serious damage was being done at the coast timber yards where, especially at Dar-es-Salaam, faulty methods of stacking and inadequate inspection had resulted in wholesale damage to much valuable timber.

A short illustrated bulletin was written and published by the East African War Supplies Board, Timber Control. This describes the principal types of insect damage to timber, and the various insects responsible; and gives suggestions for preventing or limiting the damage.

During the absence of the Director, on duty and leave, for several periods during 1944 and 1945, the Entomologist was Acting Director. He had proposed to occupy the intervals between these periods in compiling a text-book of East African Agricultural Entomology. There can be little doubt about the need for such a text-book and the proposal received the approval of the Agricultural Adviser to the Secretary of State, and of the Director of the Imperial Institute of Entomology. The East African Standing Agricultural Research Committee were, however, definitely opposed to the suggestion, although they were unable to put forward any feasible alternative project for the Entomologist to undertake. The proposal was therefore dropped.

SOIL SCIENCE

Geoffrey Milne, Soil Chemist, died suddenly in January, 1942. W. E. Calton, Scientific Assistant, served with the forces until his appointment as Assistant Government Analyst, Tanganyika on 1st January, 1943. H. B. Stent, Soil Chemist of the Department of Agriculture, Tanganyika, who had been seconded to this Institute in November, 1940, was lent to the East African Industrial Research and Development Board in Nairobi throughout 1942 and for the greater part of 1943. In July that year, however, he undertook a soil survey of certain areas in the Northern Province of Tanganyika in connection with the wartime wheat production scheme. The following is a summary of the results of his survey:—

"(1) *Ngare Nairobi Area.*—The soils of the upper lands are deep clay loams, well drained and of good structure: those of the lower area are shallower, more alkaline and of heavier texture. The occurrence of gall acacia is not indicative of unfavourable soil conditions.

"The soils of the lowest areas are variable in depth, sometimes very shallow and rainfall is probably unfavourably low.

" All areas possess ample reserves of mineral plant foods: humus content is not high, but probably adequate.

" (2) *Ardai Plains Area.*—An area of calcareous black clays, heavy in texture: neutral or slightly alkaline in reaction at the surface, becoming more alkaline with depth. Soluble salts are not present in appreciable quantity, but the ratio of exchangeable alkalies to alkaline earths is sometimes high in the subsoil. There are ample reserves of mineral nutrients, but the humus content is on the low side. Downward movement of soil moisture may be slow, but drainage in the deep subsoil is good owing to the accumulation of kunkar limestone over a porous parent rock. Cultivation during the rains will present difficulty.

" (3) *Mbulumbulu Area.*—These soils possess the highest nutrient status of all the wheat-scheme lands: they are rich in humus as well as in mineral nutrients. They are of good loamy texture and crumb structure and freely drained. The profiles are slightly acidic while possessing ample reserves of bases." (H.B.S.).

H. B. Stent returned to Amani from March to August, 1944, when he was seconded to the East African Industrial Research Board, Nairobi. While at Amani he made a preliminary soil survey of certain West Usambara Cinchona estates.

He also made a number of analyses of derris and of soils at Kwamkoro on which it had been grown. He reported that in field experiments considerable block variation was found. In one manurial trial, for example, the rotenone content of the root varied between 6 per cent. and 11 per cent. for a single treatment replicated six times. The main variable soil factor in the soils was found to be the base status, the order of difference being between four and one milligram equivalents of exchangeable bases per 100 grams of soil.

D. W. Duthie, who had been appointed to succeed G. Milne in October, 1942, did not arrive at Amani until August, 1944. As a preliminary he made extensive tours in Tanganyika, Uganda and Kenya, during the course of which, while visiting the Northern Province of Tanganyika in October, two short investigations were carried out in collaboration with the Plant Pathologist, Department of Agriculture. One concerned the failure of sisal and sugar cane on the Tanganyika Planting Co.'s estate at Arusha Chini, where pathological examination had failed to explain the cause, and the Plant Pathologist had suspected salt poisoning. This proved to be the case, and small-scale trials by the management, followed by soil analyses at Amani, showed that the salts (chlorides and sulphates of soda and magnesia) could be washed out relatively easily. These are being followed by planting trials, carried out by the estate authorities. The second investigation concerned a disease of pawpaws in papain plantations near Mbugwe, Northern Province. This was found by the Plant Pathologist to be due to a fungus (*Phytophthora parasitica*), and check tests on the soil showed that soluble salts were not present in excess.

During February and March, 1945, Dr. Duthie visited the Southern Highlands Province of Tanganyika, chiefly for the purpose of examining areas proposed for European settlement. He reports as follows.

Of these the Lower Dabaga (Mtitu Nguruhe) area was the most interesting, since German settlement there had been on a fairly large scale prior to the war. The laterised red earth of this district has retained some superficial

fertility, but it is strikingly deficient in available phosphate and is generally low in plant nutrients. However, the loamy texture gives good promise of improvement by liming, applications of phosphate, and by grass rotation, compost manuring or green manuring. Although the soil in its present state should give reasonable crop yields, it is essential that a long-term programme of soil improvement should be part of any development scheme in this area.

" The Upper Dabaga area is under short grass, on a highly laterised grey-brown sandy loam. This is a highly leached soil of low natural fertility which would probably be difficult to bring into good heart. Transport charges would be high for chemical fertilisers and this might limit soil improvement. Compost, grass rotation, green manuring, lime and phosphate would all be required, but on the whole it seems better to extend the cultivation of pyrethrum. The soil is not really suitable for mixed farming, although with good husbandry and chemical fertilisers much improvement could be made.

" Another area which had been considered for development is at Nduli, about 12 miles north of Iringa. At present there are four holdings of about 500 acres each, but the total possible development runs to 20,000 acres. The soil varies from coarse sand to heavy loam, and is derived from the weathering of granite kopjes. The colour varies from yellow-brown to dark brown, with one large patch of bright red soil. Tobacco has been grown here for three years, and its rather coarse growth indicates that the land is still too rich in nitrogen for good quality. It would be better to take off a crop or two of maize before planting tobacco, and then to make up the deficiencies of lime, phosphate and potash by adding these through the medium of highly fortified compost. It must be emphasised that the cultivation of flue-cured tobacco for cigarette manufacture requires heavy applications of fertilisers, principally potash, in order to produce the necessary leaf quality. A great improvement in variety is also necessary, and, on the whole, the industry requires much modification before it is likely to be successful.

" A visit was paid to the Pawaga Irrigation Scheme under the Iringa Food Production Committee. The land lies below the Iringa Escarpment, about 30 miles from the town, and the low rainfall of the area can be offset by irrigation from the Ruaha River. The danger was obviously salt in the soil and samples confirmed the presence of some salts (nearly 1,000 parts per million), probably the sulphates and chlorides of sodium and magnesium. As the Ruaha water was found to be very low in salts, it is fairly certain that any detrimental effect of salts would rapidly disappear with irrigation.

" Lord Chesham's settlement scheme on the Southern Highlands Estate, Ltd., also came under consideration. The soil here is highly laterised and will require both chemical fertilisers and organic manure in order to produce profitable crops.

" I attended a meeting of the Southern Highlands Development Committee, and submitted a memorandum setting out most of the relevant points in connection with soil improvement in settlement schemes.

" *Tea Yields at Tukuyu, Southern Highlands Province, Tanganyika.* The yield of tea at one estate had been causing some concern in recent years, as it had dropped to an unprofitable level. The distinctive symptoms was severe chlorosis, and soil samples were taken from a range of fields in order to find the limiting factor. The analytical data showed satisfactory acidity, nitrogen, and organic matter, with extremely low available phosphate. As phosphate

is seldom a limiting factor for tea yield, this could not be put down as the key factor, although it was obvious that the quality of leaf should benefit from applications of phosphatic fertilisers. On the whole, the evidence pointed to incipient sulphur deficiency, which could be corrected either by ground sulphur or by sulphate of ammonia. A report on the subject has been submitted to the Director of Agricultural Production, Tanganyika." (D.W.D.)

J. Eden, Scientific Assistant to the Soil Chemist, arrived on first appointment in November, 1944 but resigned his post in January, 1945.

In the absence of any assistance it is clearly impossible for the Soil Chemist to undertake any project involving much analytical work nor can any progress be made in tackling the arrears that have accumulated during the past 15 years. There are in the Amani laboratory over 5,000 soil samples, representative of wide areas of East Africa, which await analysis. The application of soil science to practical problems of fertility must inevitably be handicapped until such analyses can be undertaken.

BIOCHEMISTRY

The Biochemist, R. R. le G. Worsley, was almost entirely occupied during 1942 and 1943 on special investigations arising out of the war. These are reported on below under the separate subjects.

Dr. Worsley went on leave in February, 1944 and for various reasons did not return until February, 1945 when he was seconded to the Veterinary Research Laboratory, Kabete, Kenya. Dr. (Mrs.) E. C. Halpern was appointed temporary assistant chemist in August, 1942, and has been employed on laboratory investigations on Cinchona. In April, 1945 she was transferred to the Cinchona Research Organisation.

PLANT PHYSIOLOGY

The senior Plant Physiologist, F. J. Nutman, was seconded to the East African Industrial Research & Development Board in March, 1943 and subsequently, in 1945, to the Tanganyika Government for service at the fibre board factory at Shume. Prior to his secondment he had been in charge of the camphor factory at Lushoto, had conducted preliminary work on the local manufacture of fibre-boards, and had been engaged on other problems arising directly out of the war.

The second Plant Physiologist, J. Glover, had also been engaged on war problems up to April, 1944.

Since it appeared, from a bibliography recently compiled by R. E. Moreau, that very little information existed about the physiological behaviour of the potato in the tropics, he then started an investigation into the effect of fertilisers and climate on the growth and yield of potatoes (*Solanum tuberosum*) at altitudes below those at which they are commonly grown in East Africa.

The following is taken from his report. " Two experiments were made simultaneously in the ' cool season ' (June-August) at 3,000 ft. and 600 ft. above sea level. A third was made at the higher site during the ' hot season ' (November-January). All were at latitude 5° 09'S. The variety used was Kerr's Pink supplied from ordinary commercial stocks grown in Kenya. The tubers were of uniform size. The manures were farmyard manure, nitrogen, phosphate, potash and lime used singly and in all combinations. They were applied at the following rates:—farmyard manure at

12 tons per acre; ammonium sulphate at three cwts. per acre; rock phosphate at four cwts. per acre; potassium sulphate at two cwts. per acre; and lime (carbonate) at 15 cwts. per acre.

" Since the effect of manure on yield was well marked in all the experiments it is difficult to summarise adequately all the data in limited space. Farmyard manure and nitrogen greatly increased the yield by weight of tubers and also increased the number of tubers above those of the controls in all the experiments. In some, phosphate and potash had similar but less marked effects.

" Environmental factors measured continuously throughout the growing period at each site and in all three experiments were: air temperatures; saturation deficit; rainfall; soil temperatures at different depths, both in bare soil and under the plants in the drills. In one experiment a continuous record of the vertical component of total solar radiation was made; in another evaporation and wind were also recorded.

" The following table summarises the results from the best plots, that is, those which yielded seven tons per acre or more. As no plot at the lower site reached this value only the yield from the best plot is shown.

Exp.	Altitude a. s. l.	No. of plots	Treatment	Average total yield in tons/acre	Average yield of ware above 1⅝" in tons/acre	Average per cent. ware	Life in days from planting to harvest
Cool Season	3,000 ft.	1	DN	9·1	7·1	78	95–100
		3	DNP, NPK, DNL	8·3	6·5	78	
		3	DPL, DNKL, DNPKL	7·5	5·6	75	
	600 ft.	1	DN	5·2	3·7	71	83–90 (died of drought.)
Hot Season	3,000 ft.	1	DNKL	10·6	9·0	85	100
		3	DN, DNL, DNPL	9·5	7·8	82	
		4	DPL, DNPK, DNP, DPKL	7·5	6·0	80	

D=farmyard manure: N=ammonium sulphate:
P=rock phosphate: K=potassium sulphate:
L=calcium carbonate.

" The yields at the higher site would be considered adequate by English standards. That at the lower site was poor, though reasonably good considering the short life of the plants. The probable explanation of the low yield at the low altitude was found by the analysis of the records of the environmental factors to be lack of water. The plants of both experiments at the higher site received approximately 20 inches of rain during their life, while those at the lower received only eight inches. Length of day was not

responsible for the low yield since the cool-season experiments were made simultaneously and the one at the higher altitude gave good yields. High air- and soil-temperatures were also not responsible for the low yields, for the hours of exposure of the plants to different levels of temperature, night and day, were almost identical during the cool season at 600 ft. and the hot season at 3,000 ft., and the plants of the higher site gave good yields.

" The conclusion reached is that, given (1) adequate manuring and attention similar to that of English practice, (2) an adequate supply of water, and (3) healthy ' seed ' tubers such as those supplied to this Institute from the commercial stocks of Kenya; then at 3,000 ft. above sea level in the Usambaras when the mean maximum monthly temperature is 27°-28°C. (80°-82½°F.) and the mean monthly temperature is 22°-23°C. (73½°F.) the plants will give a yield per acre similar to that in the temperate zones. In the cool season at 600 ft. above sea level a similar result should be obtainable." (J.G.)

On completion of his work on potatoes, J. Glover started an enquiry into the possibilities of a study of soil—water—vegetation relations. In October, 1945 he visited parts of the West Usambaras with a view to finding a suitable site for preliminary experiments, and later went to Dar-es-Salaam to consult Mr. C. Gillman (formerly Water Consultant of Tanganyika) and Mr. L. L. R. Buckland (Deputy Director of Public Works, Tanganyika) on various problems of water conservation.

In December, 1945 he went to Shume in the West Usambaras and started to test field equipment for the daily measurement of soil moisture beneath different types of vegetation, and for the measurement of run-off and penetration of rain under natural vegetation and cultivated land on different soils and slopes.

Although these preliminary experiments are not yet complete it is becoming evident that an investigation of this nature on a scale sufficiently large to be of practical value would entail a very large technical staff and the use of much expensive equipment. While there is little doubt that a thorough investigation of the interacting effects of natural vegetation, crops, land use, climate and topography on soil moisture would be of scientific as well as of practical value, it may turn out not to be a feasible undertaking.

If this should be so, a less ambitious programme is suggested, involving the study of the water relations of the principal native food crops and their effect on the absorption, percolation and storage of rain in the soil.

PLANT GENETICS

Very little genetical or cytological work has been possible between 1942 and 1945. The Geneticist, L. R. Doughty, was lent to the Tanganyika Department of Agriculture until May, 1942, when he returned to Amani to act as Superintendent of Plantation until the arrival of L. M. Fernie in December, 1943. He was subsequently employed almost entirely on Cinchona and in April, 1945 was appointed Director of the newly formed Cinchona Research Organisation.

The following are extracts from his reports:—

" *Agave*. In 1943 twenty-four smooth-margined plants of an F_1 hybrid, *Agave angustifolia* × *Agave amaniensis*, were selfed and also pollinated with *Agave amaniensis* pollen. The resulting F_2 generations are being raised at the Sisal Experimental Station, Ngomeni.

" Reciprocal crosses were also made between *Agave amaniensis* and the following species: *Agave horrida, Agave zapupe* and *Agave brandegeei,* the first successfully and the others with only moderate success. The F_1 generation from these crosses is being raised at Amani. *Agave brandegeei* and *Agave zapupe* failed to set seed on selfing.

" During 1944 more plants of the F_1 hybrid *Agave angustifolia* × *Agave amaniensis* flowered and several of them were pollinated with pollen from *Agave amaniensis,* and from *Agave angustifolia,* and also self-pollinated.

" Breeding material raised from crosses made during the 1943/44 season was planted out in a new plot at Sigi. A part of this material was also sent to the Sisal Experimental Station, Ngomeni.

" This material includes hybrids between *Agave amaniensis* and *Agave brandegeei, Agave zapupe* and *Agave horrida.*

" Crosses of *Agave amaniensis* and *Agave horrida* and the reciprocal have produced some promising plants with non-spiny leaf-margins.

" Young plants from back crosses *Agave angustifolia* × *Agave amaniensis* × *Agave angustifolia* and *Agave amaniensis* are still in the seed beds, and should be ready to put out in the field in March, 1946.

Aleurites. Little could be done except maintain yield records for individual plants. Plants raised from open-pollinated seed of selected parent plants bore a light crop only in their fourth year in the field; the mean yield of nuts was only 13 kg. per acre.

" During the seven years for which individual tree records are available there have been considerable fluctuations in yield but all trees have behaved in a similar manner, the major factor being the season. There was a marked fall in yield in 1943 and recovery has been slow, the 1945 yield still being much lower than those obtained in 1942.

" Yields per acre in kilograms of dry nuts on two Amani plots planted in 1943 were: —

	Plot 1.	Plot 2.
1939	17	60
1940	33	142
1941	50	211
1942	76	270
1943	39	118
1944	33	177
1945	46	228

" *Cinchona.* Preliminary work on Cinchona selections was begun in 1943. Plants in some of the old Cinchona plots at Amani were numbered, measured and sampled for the determination of their alkaloid content. All these plants were cut down for the 1932 harvest; the material is therefore from ratoon growth about eleven years old. Samples were taken from *Cinchona ledgeriana* and hybrid (*Cinchona ledgeriana* × *Cinchona succirubra*). Material from selected parent plants is being propagated vegetatively and from seed, the result of open pollination has been collected from some of them. Propagation by cuttings taken from young seedlings is also in progress. The tops of young seedlings root easily and it is possible to get several rooted cuttings from each seedling if the tops are taken out of the succession of shoots.

" In 1944 all ledger types in Amani, both old and young trees, have been measured and the bark sampled for determination of alkaloid content. Open-pollinated seed has been collected from plants selected for vigour of growth and high alkaloid content. Some material of these parent trees is being propagated vegetatively. The least vigorous types and those with low alkaloid content in these plots will be removed as soon as preliminary analytical work is completed. The amount of analytical work already completed reflects great credit on the only chemist available for this work.

" *Coffee.* Yield records were maintained. A hybrid between *Coffea eugenioides* and *Coffea excelsa* flowered for the first time in 1944 and produced a fair crop, the seeds of which were viable." (L.R.D.)

SYSTEMATIC BOTANY

During the four years under review the Botanist, P. J. Greenway, received for naming 373 consignments of botanical material from various government departments, commercial firms and private individuals in East Africa, as well as from Ethiopia, Somalia and Portuguese East Africa. The number of specimens in these consignments amounted to over 13,500. The number of determinations made (which included some arrears from previous years) was 18,700. The Amani Herbarium was increased by some 10,600 specimens, and now totals 52,500 specimens available for study. The number of known isotypes is now 369. 4,500 named specimens were distributed to the Royal Botanic Garden, Kew; the National Herbarium, Pretoria; and various other institutions in England, Africa, America and Australia.

Information has been supplied to numerous correspondents on the economic possibilities of various plants in East Africa and elsewhere, especially in connexion with the war effort. Some of the subjects covered were rubbers, dyes, tannins, fibres, gums, timbers, fuels, saponins, fats, poisonous plants and noxious weeds, food and beverage plants, rope preservatives, rattans, drug plants, essential oils, and many others.

In spite of the ever-increasing amount of work entailed by these routine determinations and requests for assistance, the Botanist, although entirely single-handed, was able to undertake a certain amount of field work, the following notes on which are extracted from his reports.

" In 1942 one month was spent in the field in an area known to be rich in succulent Euphorbias in connexion with investigations into alternative sources of rubber. Eleven different samples of latex were collected as well as botanical material, and a report has been submitted to the Director. Analytical results on the rubber content of the latices were disappointing.

" I accompanied the Director on a visit to the Department of Animal Health and Veterinary Science at Mpwapwa, Tanganyika, where pasture research matters were discussed." (P.J.G.)

In 1943 a botanical survey was made of potential wheat areas of the Northern Province, Tanganyika; a survey of additional areas was made in 1944, when a weed survey of the land already under wheat was undertaken.

" During 1945 I spent from January to May on a visit to Uganda, returning by way of the Lake Province of Tanganyika. In the company of Dr. Eggeling and Mr. Hummel (Forestry Department) I collected in the western and northern parts of Uganda and visited Serere. With Mr. Thomas (Agricultural Department) I went to the Sese Islands and saw the vegetation adjacent

to the Lake in the area from Entebbe to a little north of Kampala, and around Jinja. There are quite a number of new and little-known species in the collection, including a new East African Camphor (*Ocotea* sp.) from the Imatong Mountains.

" I examined the botanical collections of the Forestry Department at Entebbe and that of the Agricultural Department at Kawanda.

" At Mwanza a few days was spent in examining the Lake-side vegetation and I visited the Ukiriguru Agricultural Experimental Station where I collected, as well as named, a number of grasses on trial for grass leys.

" From Mwanza I went to Old Shinyanga to visit the Tsetse Research Department and to examine their herbarium, where I spent about a week. They have a very useful collection of botanical specimens from most of the tsetse-infested areas of East Africa, particularly from Tanganyika, Northern Rhodesia and Nyasaland, and they appear to have a complete set of botanical specimens collected by the late director, Mr. C. F. M. Swynnerton, in Gazaland.

" In Shinyanga I spent a few days naming collections of grasses and I also visited the Lubaga Agricultural Experimental Station where I named grasses under trial for grass leys besides collecting interesting specimens of the local flora.

" In June-July I spent ten days in the Northern Province, Tanganyika, continuing my weed surveys of wheat-fields. There appears to be as yet little change in the weed flora, but the weeds were not as numerous as in the previous survey, perhaps in part due to the land having been longer under cultivation and to a closer and heavier sowing of the wheat-fields.

" At the end of July a few days were spent in Dar-es-Salaam having discussions with Mr. C. Gillman, C.B.E., and the Survey Department on vegetation mapping and classification. The preliminary draft of the Vegetation Map of Tanganyika prepared by Mr. Gillman for the Vegetation Classification Committee has been completed.

" Collaboration with the Imperial Forestry Institute on the Tanganyika Check-list of trees and shrubs has been maintained, and with the National Herbarium, Pretoria, on a monograph of the succulent Euphorbias of Tropical Africa.

" The late Father Conrads' herbarium has been received from the King George V Memorial Museum, Dar-es-Salaam. This is an important collection of about 3,000 specimens, mostly collected in the Lake Province of Tanganyika. Many have been named by Continental botanists, and some type specimens are included. Unfortunately, however, Father Conrads' field data appear to have been lost." (P.J.G.)

ZOOLOGICAL WORK

The Secretary-Librarian, R. E. Moreau, has to some extent been able to continue his—largely extra-official—ornithological studies, in which he reports as follows:—

" Since the outbreak of war, pressure of office work and lack of transport have made it impossible for me to do any field work or to pursue any major line of work consistently. I have, however, been able to continue using one or two Africans for collecting and routine observations with excellent results and I owe much also to correspondents.

" During the period under review I had drafts of papers, intended for publication in the United Kingdom and elsewhere, sent to me for comment from Kenya, Uganda, Tanganyika, Zanzibar, Nyasaland, Somalia, Ethiopia and Madagascar. I have myself worked on the following lines:—

" (1) My comparative study of clutch-size, with particular reference to African birds, which began in 1938, was published in 1944. It demonstrates, for the first time on the broad basis of an entire avifauna, that there is a marked tendency for the size of the clutch in the same species, or as between closely allied species, to increase with latitude. This conclusion, and other subsidiary points that emerge, raise evolutionary and ecological problems of great interest.

" (2) Following the interesting results obtained from collecting in 1940 and 1941 on the highlands east of Lake Tanganyika, further collecting was done at Kasulu and south of Kigoma in Ubende (on the Uvinza-Mpanda road). The results show that West African faunal elements long recognized in Bukoba extend much further south into Tanganyika Territory. An attempt was also made to see whether the absence of evergreen-forest species from the published lists of birds for the islands in the southern part of Lake Victoria, especially Ukerewe and Kome, correctly reflected the facts. Actually only a few additional species were found, but they indicated more extension of West African affinities than had previously been recognizable. During my leave I worked on these collections and also some specimens obtained by Mr. R. M. Bell in Liwale and Songea. The significant features of these collections are being published.

" The selective collecting on these lines that has been done at intervals since 1930 is at last making a clearer view of the local avifaunal affinities possible and brings within measurable distance the comprehensive statement of the evergreen-forest faunae of East Africa, and their discussion from the evolutionary point of view, that has been a project of mine for so many years.

" (3) As opportunity occurred more data were collected on the nest-behaviour rhythms of birds of the swallow family at Amani. The figures derived from the thousands of hours of observations now amassed have been collated and Professor R. A. Fisher has been good enough to arrange for their statistical analysis. It is hoped to prepare some of the results for publication.

" (4) Life-history studies of a kingfisher (*Alcedo semitorquata*) and of the bateleur eagle (*Terathopius ecaudatus*) have been carried out with the help of African observers and published. The kingfisher study is probably the most detailed that has been made for a bird of this family at the nest, and it enabled me incidentally to estimate fairly closely the amount of fish taken. The bateleur study included the first consistent observations that have been made at the nest of this peculiarly interesting and most characteristic African bird; and the opportunity was taken to collate all the previous literature about it.

" (5) Much has also been learnt about the behaviour of two local birds, the mountain wagtail (*Motacilla clara*) and the paradise flycatcher (*Tchitrea*), which are of special interest for future comparative studies. The wagtail has a more closely allied Temperate-zone species (*Motacilla cinerea*) than almost any other Tropical African passerine bird; and when as much is known about *M. cinerea* as we know about *M. clara* a comparison of behaviour at the nest will be valuable.

" The paradise flycatcher belongs to a genus having noteworthy features apart from its high degree of plumage-specialization. Although the birds are apparently unfitted for prolonged flight the range of the genus extends from Senegal, eastwards through the islands of the Indian Ocean, as far as Japan. The members of the genus have remained surprisingly similar in their morphology, and the preliminary indications now are that this applies also to their behaviour.

" (6) A comparison of the higher-vertebrate faunae of Mt. Kenya and Kilimanjaro from the evolutionary and zoo-geographical point of view seemed to offer an interesting study. I found, however, that the existing information was, even for Kilimanjaro, so scattered and so defective that a definitive comparison cannot yet be made. In the end I published a paper on each mountain, collating all the available information on the birds and mammals, and setting it on the background of the local vegetation and geography.

" (7) As I have remarked before, one of the major problems of tropical biology is the periodicity and the physiological mechanism of the birds' breeding-seasons. As a contribution to the study specimens of each of three selected species were collected here at fortnightly intervals over twelve months during 1938-39. The gonad-material was sent to Professor W. Rowan, and now, after the delays occasioned by the war, its examination has been completed. A joint paper on the moult- and gonad-cycles has been drafted.

" (8) At the orginal suggestion of Mr. G. H. E. Hopkins, and in collaboration with him and Mr. R. W. Hayman of the British Museum, as many as possible of the type-localities that were obscurely or imperfectly stated in the standard ' Checklist of African mammals ' (G. M. Allen, 1939) have been elucidated. About 350 forms, mainly in East Africa, have been dealt with and the paper is appearing in the *Protocol Zoological Society, London*.

" (9) Partly in response to a request for information from the British Museum an effort has been made to find out as much as possible about the genus of small parrots (*Agapornis*), commonly called lovebirds, which are of economic importance in parts of Tanganyika Territory, and which are excessively ill-documented A preliminary paper has been published locally with a view to arousing interest. Meanwhile a study of the genus as a whole, which I also pursued while on leave in England, reveals features of outstanding interest; and a paper on the genus from the evolutionary point of view is being completed.

" (10) The *Chlorophoneus* genus of bush-shrikes includes perhaps the most remarkable cases of polymorphism in the higher vertebrates. A point of special interest is that our collections have established geographical variation in the proportions in which the polymorphs occur. The study is being pursued in collaboration with Mr. H. N. Southern of the University Museum, Oxford." (R.E.M.)

CINCHONA

At the request of the East African Committee of Production, during 1942 experiments were undertaken in laboratory and field to investigate the claims made for the Russian or short-term method of Cinchona production. The results of laboratory investigations by R. R. Worsley were not encouraging, alkaloid yields being excessively low from one and a half-year-old plants and the totaquina produced below the required standard, mainly owing to the large amount of amorphous alkaloids and colouring matter present.

Bark prunings from three- to five-year-old trees, normally wasted, gave better extracts than "Russian" material. During these investigations a percolation method was perfected to replace the normal stirring process which was found unsatisfactory for extracting the alkaloids of low-grade material.

Nursery trials showed that vegetative propagation of Cinchona was most rapid and successful when cuttings were obtained from leading shoots of ten-months-old seedlings. Such cuttings, raised in hot beds, rooted in 13-21 days.

Small-scale manurial trials were laid down in the field.

A considerable number of analyses were made in connection with Cinchona selection.

In June, 1943, £5,000 was advanced by the Government of Tanganyika for laying down extensive Cinchona nurseries, with the object of increasing supplies of quinine or totaquina. By the end of 1943, 70,000 seedlings had been transplanted into beds and a further 250,000 were ready for transplanting. The species and varieties represented in the nurseries were:—

(1) C. *ledgeriana* (*a*) Amani strain; (*b*) Indian strain from Munsong; (*c*) Indian strain for six-year-old plants at Amani; (*d*) Java strain from Philippines; (*e*) three Amani selections.

(2) C. *josephiana*.

(3) C. *hybrida*.

(4) C. *succirubra*.

Further experiments, incorporating manurial trials, on the short-term Russian system, were undertaken, but this method continued to prove disappointing.

Until 1943, mainly owing to lack of staff, no serious efforts could be made to select high-yielding types from the Cinchona plantations at Amani and Kwamkoro. The appointment of Dr. Halpern as a temporary assistant chemist has allowed preliminary selections to be made from the old Amani plantations established many years ago from Java seed. Material from selected trees was propagated from seed and cuttings for future trials. Apart from material from the Amani plantations, some hundreds of analyses were made of bark from individual selected trees in Usambara and Uganda.

In February, 1943, the Geneticist, who was in charge of all Cinchona field experiments, visited the Belgian Congo to study the work being done on Cinchona at Mulungu and elsewhere. He also toured the Cinchona plantations in West Usambara and Uganda.

During 1944 H. B. Stent made a preliminary survey of Cinchona plantations in the West Usambaras and did a number of soil analyses to study the relation between soil fertility, alkaloid content and development.

Two factorial manurial trials were laid down in six-year-old plantations at Kwamkoro to test the influence of cotton seed, phosphate and lime on development and alkaloid content.

All ledger types, young and old, in the Amani plantations were measured and analysed, and selections were made from those trees exhibiting outstanding vigour and high alkaloid content.

A considerable amount of work on the vegetative propagation of Cinchona has been done by L. M. Fernie who reports as follows:—

"(*a*) Root cuttings have rooted but shoots have not developed.

"(*b*) Leaf cuttings have rooted successfully when planted with the petiole inserted in the rooting medium, but shoots have not developed.

" (*c*) Leaf-bud cuttings have rooted and shoots have developed subsequently, but it is not considered to be a practicable economic method.

" (*d*) Hardwood stem cuttings have rooted, but slowly; after-treatment has proved difficult.

" (*e*) Softwood stem cuttings. This has been the most successful method of vegetative propagation by cuttings. As may be expected with this type of material, the use of glazed propagating frames is essential to maintain a high humidity and prevent the cuttings from wilting; success is dependent on the retention of a proportionate leaf area.

" Great variation in ability to root is shown among Cinchona species and varieties.

" C. *succirubra* proved easy in all treatments; C. *josephiana* was the most difficult to root.

" Other conclusions were:—

" (i) Washed river sand alone (to a depth of four inches) is a more satisfactory rooting medium than a mixture of coconut fibre and coarse sand.

"(ii) Bottom heat (as provided by fermenting cow manure) is not necessary. Indications are that rooting may be slightly hastened by its use, but over a prolonged period cuttings root better without it; it is of more value when used in conjunction with the coconut fibre/sand rooting medium than the sand alone.

" (iii) Cuttings taken as suckers or tops from main stems were easier to root than those taken from branches. This may in part, be due to the fact that the suckers are more genuinely true softwood cuttings, whereas the branch cuttings tend to be slightly hardened at the base. Furthermore, suckers and tops are normally stronger and more active in growth than branches.

" (iv) The usual practice with cuttings is to make the basal cut through or just below a node. In the case of Cinchona, cuttings with the basal cut through the middle of an internode have also rooted well, though a higher percentage was obtained when the more usual nodal cut was used.

" (*f*) Grafting. Experimental and practice grafting, including the training of African staff, was commenced. In all cases scions were taken from trees of C. *ledgeriana*.

" In the nursery, trials were conducted using both cleft and side grafts on two-year-old hybrid seedling rootstocks. The cleft grafts were tied with raffia and covered with waxed paper covers—no grafting wax was used; the side grafts were tied with raffia and the point of union sealed with wax, but they were not covered. The weather was mainly hot and dry with occasional thunderstorms; plants were watered when necessary. After one month, 60 per cent. success was recorded with the cleft graft and 36 per cent. with the side graft; all grafts were done by African trainees under close supervision.

" Experimental grafts were also made on to the ratoon growth of old hybrid plants in the field. Cleft, rind, and side grafts were all tried, the latter again proving to be the least successful." (L.M.F.)

In April, 1945, all work on Cinchona was taken over by the newly-formed Cinchona Research Organisation, to which L. R. Doughty was seconded as Director. The objects of this organisation are to ascertain where Cinchona can be grown in East Africa and with what prospects of commercial success and to provide for research and advice to assist the development of Cinchona planting anywhere in the Colonial Empire where conditions are suitable.

RUBBER

Prior to the arrival of the Rubber Chemist in 1943, R. R. Worsley investigated the rubber yields of species of succulent Euphorbias collected by the Botanist in the Paré district of Tanganyika. None of them yielded latex in sufficient quantity, and the low proportion of caoutchouc and excessively high proportions of resins in the latex rendered these Euphorbias unsuitable as a source of rubber. He also examined numerous samples of wild and plantation rubber for resin, impurities and moisture content. Work was also done on the preparation of coagulants for ceara latex.

In April, 1943, it was decided that this Institute should be the centre for the collection, co-ordination and dissemination of information on the technical aspects of war-time rubber production in East Africa, and in that month J. D. Hastings, Rubber Chemist, arrived at Amani. Shortly after his arrival he made a tour of representative rubber areas in Kenya, Uganda and Tanganyika. The following extracts are taken from his annual report for 1943:—

" From the survey made it appeared that the rehabilitation and development to production of the Tankanyikan estates involved at that time mainly administrative and constructive work on which no assistance could of course be given. It was evident, however, that many problems would shortly arise calling for technical advice. Uganda Hevea production had been established for some time and production was proceeding satisfactorily, whilst the organisation of the collection of the small quantity of wild rubber available had been ably undertaken by the Controller of Rubber appointed by the Uganda Government. In Kenya wild rubber collection was well organised under the Department of Agriculture and although the amount then collected was lower than anticipated this was due to uncontrollable circumstances. The few Ceara estates in Kenya would it was thought encounter problems of a similar nature to the Tanganyika estates. My most important functions were therefore likely to be concerned with *ad hoc* investigations and technical advisory work on problems as they arose. A short programme of investigations was accordingly drawn up after the survey and work commenced on some of the items.

" Coagulation and Manufacture of Ceara Crepe.

The preparation of sheet rubber on the Tanganyika estates was at first impossible as there were no rolling machines; the coagulum was being railed to Tanga where a crepeing plant had been erected. Difficulties were experienced in manufacturing a normal thin crepe. Ceara, unlike Hevea latex, coagulates when diluted with water without addition of coagulant. On some of the estates coagulation was starting so rapidly that mixing of the latex and water was not uniform and there was hardly time to get the partitions into the coagulating tanks. It was thought by the factory that variation in condition and water content of the coagulum might be responsible for the crepeing troubles. Investigations were started to find an anticoagulant which would delay the onset of coagulation sufficiently to permit efficient mixing of the latex and later to carry out machining experiments with coagula so produced.

" Laboratory experiments indicated that anticoagulants and preservatives of Hevea latex were not satisfactory for Ceara latex when used in normal or even twice normal amounts, coagulation was in fact more rapid in some instances. It was only when larger quantities were added that they were effective and even then coagulation of the froth and local surface clotting still occurred, although coagulation of the bulk of the latex could be held up.

Of the materials tried, saponin, borax, sodium carbonate and sodium sulphite were the most satisfactory and the amounts necessary to keep the latex fluid for convenient handling were determined. These were found to depend on the purity of the water used for dilution and as this varied on different estates, particularly with regard to acidity, no recommendations universally applicable could be given. Saponin solutions were outstandingly the best and with these local clotting and coagulation of the surface froth can be entirely eliminated. With sodium carbonate it is possible to accelerate, retard and again accelerate the speed of coagulation by progressive increase in the amount added.

" Subsequent machining experiments, carried out on the battery of crepers at Tanga, showed that the quality of the crepe was not improved by controlling the speed of coagulation or by variation in the amount of water used for dilution and coagulation. It has not yet been possible either by alteration in machine settings or the number of machinings given to effect a noticeable improvement in the quality of the crepe produced which is of a thickish slow-drying type. From comparative machining experiments made with Hevea and Ceara coagula it is evident that the Ceara coagulum behaves in a different manner during crepeing; it crumbles and tears in the early maceration but does not knit readily on the following machines to produce a thin crepe. No better results were obtained by machining with hot water or by soaking the coagulum thoroughly in hot water between each machining. Since no improvement in the crepe results from the use of an anticoagulant, and large quantities would be needed if they were to be used, their use was not recommended. Experiments were carried out with the berries of *Sapindus saponaria,* a tree which grows well in the Tanga area and is a well known source of saponin, to see if a suitable anticoagulant extract could be prepared easily, but the trials were not promising.

" Coagulation of Funtumia Latex.

The latex of both *Funtumia* and *Clitandra orientalis* is difficult to coagulate. Formalin, which has been found by previous workers to be the most satisfactory cold coagulant for *Funtumia,* was not available in Uganda, the only East African territory where the rubber is produced. The method of coagulation there is a modified form of the older boiling method using *Bauhinia* extract. The average rubber particle size in *Funtumia* latex is known to be smaller than that of Hevea. Experiments were made with *Funtumia* latex obtained from Uganda to see if it would behave similarly to centrifuged Hevea skim, which is also difficult to coagulate but which reacts well with combinations of magnesium salts and sodium silicofluoride. No satisfactory coagulation was achieved, although the latex was partially coagulated on arrival and that which remained fluid was probably less stable than fresh latex would have been. Experiments with alkaline digestion by proteolytic enzymes prior to the addition of various coagulants were not successful, nor were attempts to obtain a controlled coagulation by the use of polar-non-polar fluids added to the diluted latex. In Uganda the quality of the dry sheet resulting from the use of the boiling *Bauhinia* extract is good and further work is not considered necessary since there are other problems of more pressing importance.

" Wild Rubber.

Improvements in the quality of the wild rubber collected from the lianas common to East Africa, mainly *Landolphia Kirkii,* have already been made, and natives are in many parts now bringing their rubber for sale in the form of reasonably clean sheets built up from the thin strippings from the

vines. The amount collected is small and it has been suggested that production of rubber would be increased materially by collection of the lianas and mechanical extract of the bark. The vines are scattered throughout the territories of East Africa together with others such as *Landolphia florida* of similar appearance but with a latex of low rubber- and high resin-content and consequently of no value. They often occur together in secondary forest in areas far from road or track and where penetration is difficult. Unless the extraction plants were small, easily portable and could start work shortly after being brought to the place where it had been decided to extract, there would be little hope of their successful use since the difficulties of bark collection and transport to a central site, necessarily distant, would render the scheme impossible. With these considerations in view the type of apparatus required is one that needs little erection, can be started up quickly and driven for example from a small three or five h.p. engine. A rod or hammer mill was thought likely to be a suitable type of apparatus. Considerable experimental work has been carried out to develop a mechanical method of extraction, unfortunately with little success. A quantity of vine was collected from an area where it is plentiful and the bark stripped for the experiments. Some interesting data were obtained on the time which would be involved in cutting. It was found that the average weight of vine which could be cut per man, per day of six hours working under constant supervision, and systematically cutting down the vines without selection, was 320 lbs. This involved cutting from trees up to about 15 feet from the ground where access was possible, but no attempt was made to obtain all the liana and many yards were frequently left in the overhead tangled mass of vegetation. Of this weight approximately 36 per cent. was wet bark which lost 55 per cent. on drying. Approximately, therefore, 60 lbs. of bark might be expected per man per day, but this is considered a high figure and unlikely to be achieved by many men in Tanganyika. Stripping the bark involves considerable work and in these experiments was not done *in situ*, as it would need to be in practice in order to avoid the waste of time and labour involved in carrying useless wood to the extracting centre. The ratio of wet bark to total weight of vine was independent of its diameter but stripping was of course faster and easier with the bigger lianas.

" The quantities obtained do not agree with those obtained in South Africa where similar work has apparently been successfully undertaken and as a result of which extraction plant is now being erected. It is understood, however, that conditions are quite different there, collection of the bark by lorry is, for example, easy since the nature of the country permits lorries to penetrate through the bush to the collecting areas, almost an impossibility in East Africa.

" Experiments carried out with both a small and a larger hammer mill indicated that although the bark could be put through very rapidly too much rubber was lost whatever the size of screen used: yields of rubber, admittedly in fairly clean condition, were never more than 0.5 to 1.0 per cent. This is unfortunate as a hammer mill would have been a portable and easily erected type of apparatus. Trials were then made with a rod mill. The effectiveness of grinding in a given time to a concentrate retained on a ten-mesh sieve and in such a condition that the rubber might be extracted by washing in a scrap washer or on mills, was found to be related to the charge put into the mill and the number of rods used. A series of determinations made with constant weight of charge and different grinding times showed that the effectiveness of grinding could be improved by increasing the number of rods up to a limit beyond which there was no improvement. In all the experiments the time required for grinding was too long to be practicable.

No facilities were available for the construction and trial of apparatus incorporating air-blown removal of the powder as it was formed or other modifications which suggested themselves. After some time had been spent on the work it was concluded that although apparatus might be constructed which would fulfill the necessary requirements of portability etc. the output would be too slow and the work did not warrant the expenditure of further time at this juncture, particularly as the plant could not be used without supervision and organisation of bark collection, using labour which could be more profitably employed on the Ceara plantations.

" A tapping experiment on one of the estates, started in July, to obtain information on increased intensity of tapping and its effect on the yield and tree had given results by the end of the year. These indicated that daily tapping, instead of alternate daily, would give an increased yield with no apparent deleterious effects." (J.D.H.)

During 1944 the Rubber Chemist's work in Tanganyika was entirely advisory, in connection with Ceara plantations. He also assisted the Controller of Rubber and the Rubber Production Committee in Uganda, and paid periodical visits to the small Ceara industry and wild rubber collection in Kenya. The rehabilitation to maximum production of old and abandoned Ceara plantations in Tanganyika made considerable progress during the year, and some of the difficulties in this work are described in the following extracts.

" At a conference of the senior planters and the Rubber Production managing agents to Government which I attended at the beginning of the year, the question was discussed of using tapping systems on the estates of intensity greater than the normal half-spiral, alternate daily (100 per cent). Evidence was given that over a period of six months no harmful effects on the trees had been observed with a few experimental tasks on 200 per cent. intensity tapping, and that the dry-rubber content of the latex had not fallen to such a degree as would make it not worth while so to tap the trees. It was decided that whenever labour permitted an increased intensity of tapping should be adopted, and that I should make periodical checks on dry-rubber content. Shortage of labour has in many instances prevented its general adoption until quite recently, but where such tapping has been in practice there is nothing to indicate that the Ceara tree will not stand up without harm to continuous tapping on a 200 per cent. intensity. It has not been possible to lay out statistically satisfactory tapping experiments, managers on estates have neither the time nor the staff for the supervision and recording necessary; nevertheless, interesting results have been obtained from the two experiments that it has been possible to have carried out on different estates to compare five different systems. These will soon have completed one year of tapping; indications are that with intensities of more than 100 per cent. full spiral systems are better than half spirals.

" As the position improves concerning the supply of materials, particularly of sheeting machines which are now being made locally, central factories are being set up with enough machines to form a battery so that the coagulum need be passed once only through each machine. Advice and assistance in the layout, design and running of these factories are being given.

" The preservation of Ceara latex became a problem of importance in this connection. The latex would not stand the transport and journey to the central factory and frequently arrived partially or completely coagulated. The unsatisfactory alternative of coagulation on the estates and the despatch of the coagulum for machining and drying at the central factory had to be adopted. Laboratory and, later, large-scale experiments in collaboration

with estate managers were carried out, and recommendations made that have proved successful and enabled the latex to be held up long enough to permit transport and subsequent handling. The anti-coagulant used is a ten per cent. solution of Magadi soda, a fairly pure anhydrous sodium carbonate prepared in East Africa and available in any desired quantity without import delays or difficulties. The amount of solution needed depends on the distance over which the latex has to be transported, and the period of time for which preservation is required, but usually does not exceed two or three per cent. by volume of the latex. It is important to get the anti-coagulant into the latex as soon as possible after collection. No preservative has yet been found that will keep Ceara latex fluid for more than a day but some interesting observations have been made with certain chemicals used in rather large amounts. This work may lead to successful preservation and will be followed up as soon as opportunity permits.

" The slowing up of the speed with which coagulation occurs when the dilutant water is added to the latex was necessary on one estate where sheet is manufactured, as there was not even time to get the partitions into the tank before the mixture had set. After some experimentation a recommendation was made for the use of borax for this estate and it has now been used satisfactorily for some time." (J.D.H.)

Work in 1945 was again principally advisory, and J. D. Hastings was recalled to the United Kingdom early in October, prior to his return to Malaya. On the drying of Ceara sheet he says " it is evident that it cannot be dried at temperatures as high as those normally used for Hevea sheet, particularly in the later stages. Heat blisters frequently appear, and in practice it has been found preferable to dry at lower temperatures for longer periods. The condition of the latex at the time of coagulation probably has some effect on this blistering, but no definite connection has been observed between the rate, or the ease of coagulation after the dilutant water has been added to the latex and the onset of blistering in the wet sheet." (J.D.H.)

Another extract, which covers several points of interest, is as follows:—

" Close check has been kept on the moisture content of the air-dried crepe despatched from the Tanga factory. This crepe by visual examination is now quite dry but laboratory determinations have shown that it usually contains between one and two per cent. of moisture and it has not been possible for the factory to manufacture crepe consistently with less than one per cent. contained moisture. From determinations of the amount of moisture reabsorbed by the crepe on exposure to the air after complete oven-drying it is evident that only under very favourable circumstances would it be possible for it to have a moisture content of less than one per cent. An equilibrium content of approximately this amount appears always to be present, whilst the residual moisture which could be removed from the Tanga crepe by prolonged or heat-assisted drying is usually under 0.5 per cent. Comparison of Ceara and Hevea crepes machined at Tanga on the same battery to similar thickness have shown Ceara always to be much more absorptive. This might be expected from the higher non-rubber content of the Ceara latex. Difference between dry-rubber content and total solids of Hevea latex is about three per cent. whereas it has been found to be between 5.5 and six per cent. for Ceara latex.

" During the later part of the period under review it was possible to spend some time on laboratory work with Ceara latex. A search was made to see if a satisfactory preservative could be found. The addition of potassium and sodium carbonate solutions in large amounts to the latex permits the mixture

to be kept in a fluid condition for periods up to three weeks. No preservative however has been found which works satisfactorily in small quantities or for any long period.

"Work of a preliminary nature was carried out on the serum of Ceara latex coagulated with distilled water. A heat-coagulable protein appears to be present in much larger amounts than is found in Hevea serum. A bulk preparation of this and other interesting material has been made for subsequent investigation and comparison with that from Hevea." (J. D. H.)

OTHER SPECIAL INVESTIGATIONS ARISING OUT OF THE WAR

Camphor. As a result of successful pilot-plant experiments, a camphor factory for the exploitation of *Cinnamomum camphora* was erected at Lushoto by the Amani staff in 1942. The Tanganyika Railways designed and supplied most of the essential plant and machinery.

The factory was closed in July, 1943, the supplies of local camphor wood having been exhausted.

It was financed by the Government of Tanganyika, and managed by the various members of the Amani staff. It produced, during the eighteen months that it was in operation, approximately 61,400 lbs. of crude solid camphor and 30,500 lbs. of camphor oil. Almost the whole of this output was consigned to the Ministry of Supply, the price received for it being 3s. per lb. free on board for crude solid camphor and 1s. per lb. free on board for camphor oil. A report from Messrs. Whiffen & Son, Ltd., received in January, 1943, gave the value of this camphor as 5s. 5d. per lb. for solid and 6d. per lb. for oil, as received in London.

Ceramics. Following the demand for pottery utensils and containers, experiments were undertaken in 1942 by J. Glover, assisted by Mrs. L. Goldstucker, with a view to producing these from local materials. Preliminary work showed that satisfactory unglazed ware could be made from local clays and that African labour could be taught to use the potter's wheel. Prolonged investigation in the laboratory was necessary before suitable glazes were found to fit these local clays and those submitted by the pottery workers in Kenya. In September the East African Industrial Research and Development Board voted £500 for the erection of a pilot-plant pottery at Amani which was completed early in 1943. Several months were spent in solving a series of difficult problems, mainly connected with the final firing of the glazed ware. By September, 1943, most of these problems had been solved and serviceable glazed pottery, for which there was a keen demand, was being produced on a small scale. The Industrial Research and Development Board then asked for estimates for the erection of a medium-sized pottery to be built in Tanganyika and based on the pilot-plant. This was to be financed by the Board. Later the Board asked that the pottery should be financed by the Government of Tanganyika. After due consideration the Government finally decided not to undertake this commitment. The Amani pilot-plant was therefore closed in December. The main conclusions to be drawn from this ceramics investigations, on which considerable time and effort were expended, are as follows:—

(1) That Africans, with no previous experience in working clay, can be taught to use the potter's wheel and are capable of making such articles as food-containers, mugs, cups, saucers, jugs, casseroles and tea-pots. It is extremely difficulty, however, to find an African who is capable of stoking a wood-fired kiln and keeping it at the required temperature, even when first-class wood-fuel is available.

(2) That given a good site near suitable clay, wood-fuel and water, and using only African labour under European supervision, it would be possible to manufacture glazed pottery for domestic use at a price which, in wartime, would be considered reasonable.

Chenopodium oil. This was produced on a labaoratory scale by J. Glover from *Chenopodium ambrosioides* var. *anthelminticum* grown at Amani. The sample complied with United States Pharmacopoeia standards but not with those of the British Pharmacopoeia.

Creosote. R. R. Worsley experimented with the production of creosote oil from producer-gas tar, previously considered a waste product. He produced a disinfectant of the Jeyes' type, the formula for which was supplied to a Nairobi firm for manufacture and supply to His Majesty's Forces. Medicinal creosote was also prepared. Crude creosote from local wood tar was shown by J. Glover to give satisfactory protection to wood against two common species of termites.

Dehydrated Castor Oil. A lengthy investigation was undertaken by J. Glover to discover a substitute for linseed and similar drying-oils used in paint manufacture. A method was evolved for preparing dehydrated castor oil, using East African kaolin as a catalyst. It was shown that a range of satisfactory drying-oils could be prepared by this method, details of which were published in Technical Pamphlet No. 3 of the East African Industries Technical Advisory Committee.

Petrol from oil seeds. R. R. Worsley spent a considerable amount of his time during 1942 in perfecting a process for the manufacture of high-quality petrol from oil-seeds. The process was patented in the United Kingdom.

Glycerin, Fatty Acids and Stearine. R. R. Worsley experimented with a specially constructed autoclave and demonstrated that coconut and cotton-seed oil can be split satisfactorily, on a pilot-plant scale, to produce good-quality crude glycerin and fatty acids suitable for soap making. The stearine obtained from the splitting of cotton-seed oil made good candles. The hydrogenation of cotton-seed oil free fatty acids, prepared by the autoclave process, was successfully carried out on a laboratory scale, and soap made from the hydrogenated product: this soap was hard enough for normal household use.

Malting Barley. The investigation, begun at Amani by H. B. Stent, on the possibility of producing malt from East African barley, was transferred in 1942 to Nairobi where laboratory accommodation was kindly provided by the Medical Department and facilities for experimental work provided by a firm of brewers who also undertook to erect pilot-plant maltings under the guidance of the East African Industries Research Committee. As the result of this successful investigation, which was taken over by the East African Industrial Research & Development Board, two commercial-scale maltings have been erected by Nairobi brewers for the utilization of East African barleys.

Fibre Boards. Experiments, partly financed by the East African Industrial Research & Development Board, were carried out in 1942 by F. J. Nutman and showed that acceptable fibre boards could be produced at a reasonable cost from locally available materials. A full-scale fibre-board factory was later erected at Shume, Tanganyika.

Miscellaneous. J. Glover prepared a vulcanised oil rubber-substitute for the East African Industrial Research & Development Board, and also produced school chalks and slate pencils for the East African Substitutes Committee.

R. R. Worsley worked out a process for producing calcium citrate from the juice of bitter oranges, anl also made supplies of fat from *Allanblackia Stuhlmannii* fruits for the manufacture of chocolates.

PLANTATION WORK

F. M. Rogers, who had been at first Head Gardener and then Superintendent of Plantations at Amani since 1920, retired in May, 1942, to take up work in connection with rubber production. The duties of Superintendent were then assumed, in addition to his other work, by L. R. Doughty, Geneticist, until December, 1943, when L. M. Fernie was appointed to the vacant post. The Assistant Superintendent, C. B. Gibbins, was serving with the forces throughout the four years under review. R. Doenhoff was temporary Assistant Superintendent from July, 1944, to July, 1945, and F. King-Smith from September, 1945, onwards. In spite of recurring shortages of labour, all the existing plantations were maintained.

During 1942 the following plants of possible economic importance were introduced and small plots established: *Ocimum kilimanscharicum* from Oldeani, Tanganyika Territory; *Ocimum viride* from the Gold Coast; *Chenopodium ambrosioides* from Mauritius and Kenya; and *C. ambrosioides* var. *anthelminticum* from America. The latter, however, proved unsuccessful. Other introductions were *Parthenium argentatum* (Guayule rubber) from Australia; *Ephedra gerardiana* from Kenya; and *Carum copticum* from India and Egypt, which failed to set seed in Amani. A further consignment of seeds from high-yielding trees of *Aleurites montana* was received from Nyasaland, and young plants established in the field. About two and a half tons of fresh bark of *Mundulea suberosa* was obtained from thinnings of a plantation established in 1937. Some two acres of flat alluvial land at Kwankoro was prepared for the production of fresh vegetables for His Majesty's Forces, and towards the end of the year over one ton a month was being despatched.

Introductions during 1943 included *Rheum officinale,* a medicinal strain received through the Department of Agriculture, Tanganyika; sugar cane C.O.331 from Natal; several varieties of papaw from the United States of America; and *Parthenium argentatum* (Guayule rubber) from the United States Department of Agriculture. The small plantations of *Hevea braziliensis* and a derelict plantation of *Manihot glaziovii* were brought into production: they produced, during 1944, some 11,500 lbs. of Hevea rubber and 6,500 lbs. of Ceara rubber.

Two experiments to test the optimum spacing for Derris were started in 1944, one at 3,400 feet above sea level at Amani and a replicate at a slightly lower altitude at Kwamkoro. A new variety plot for Agaves was established at Sigi. Plant introductions included the new vegetable " celtuce ", which made good growth and seeded readily; *Valeriana officinalis; Atropa belladonna; Calendula officinalis.*

In 1945 the Superintendent continued investigations on vegetatiye propagation. Those on Cinchona have been mentioned elsewhere, the following is his report on vegetative propagation of Aleurites and Cloves.

" ALEURITES MONTANA.

(*a*) *Root cuttings.* This appears to be the only possible method of vegetative propagation by cuttings. From numerous trials the following conclusions were reached: —

(i) A frame with a glazed lid is necessary; no success has yet been obtained in an open bed.

(ii) A rooting medium of coconut fibre and sand (in equal proportions by volume) is preferable to one of sand alone. Twelve weeks after setting a mass of very fine roots were visible on cuttings in this medium. Roots arose along the length of the cuttings, and not generally from the cut surface.

(iii) Cuttings have been set upright with tops above the medium, and have been buried horizontally; the latter method is more satisfactory.

(iv) Shoot development is slow and difficult. Cuttings which rooted were returned to the frames to hasten shoot development, but a high percentage rotted off before any shoots were formed. Shoots generally arose towards the proximal end of cutting.

(*b*) *Hardwood stem cuttings.* A small percentage produced some fine roots when set in a rooting medium of coconut fibre and sand in a glazed frame. Unfortunately all subsequently rotted before they were strong enough to be potted up.

(*c*) *Softwood stem cuttings.* All cuttings repeatedly rotted and died soon after setting.

(*d*) *Budding.* The training of African staff commenced.

" Cloves.

A few clove cuttings were successfully rooted in a rooting medium of washed river sand, both with and without bottom heat provided by fermenting cow manure. Time required to root was 12-16 weeks.

Success was dependent on the retention of healthy leaves; all leafless cuttings and those which dropped their leaves soon rotted and died. Softwood cuttings taken with a ' heel ' were the most promising. The use of a glazed propagating frame is essential so that a high humidity can be maintained to prevent wilting. Further trials are in progress." (L.M.F.)

A collection of exotic and indigenous lawn and pasture grasses was started, 38 plots being planted during the year. Experiments on treatment, cutting and fertilising will be undertaken when the plots are fully established.

In 1945 over 10,000 lbs. of wet latex was obtained from the Hevea rubber trees and over 5,000 lbs. from the Ceara trees on Amani land.

KWAMKORO ESTATE RE-DEVELOPMENT

This scheme was started in 1935 with the aid of a grant from the Colonial Development Fund. Its object was to ascertain whether plantation industries could be profitably established in the almost derelict coffee plantations in the East Usambaras. Trial areas at Kwamkoro were planted with Robusta coffee, Aribica coffee grafted on to Robusta rootstocks, *Aleurites montana*, *Derris elliptica* and *Cinchona* spp. It was also intended to ascertain whether or not a herd of native cattle could be successfully and economically maintained, primarily for the production of manure, and secondarily for milk and meat.

The following are the Director's reports for the years 1942-1944.

1942. " Derris continues to be the most successful of the four crops under trial. Its cultivation is comparatively simple, it is free from pests and diseases, and even on our poor, unmanured mountain soils it gives a yield of approximately one ton of dry root per acre at the age of three years. The very large demand for planting material was met.

" The serious spread of the root fungus, *Armillaria mellea*, in the largest Cinchona plantation, now six-and-a-half years old, made it necessary to begin harvesting. The yield to date of dry bark from healthy trees of *C. ledgeriana*

spaced six feet apart averaged one kilo per tree including root bark, the total alkaloid content being approximately seven per cent. The bark from newly-dead and dying trees was found to approximate closely in alkaloid content to the figure for healthy trees.

" The yield from Robusta coffee was again well below original estimates.

" The Tung plantations, *Aleurites montana,* now five to six years old, gave their first crop, a ton of shelled nuts from approximately 60 acres.

" Cattle maintained condition and few cases of trypanosomiasis occurred after June. Sheep, despite constant treatment, suffered severely from worm infection."

1943. " Labour shortage, aggravated by the reopening of a neighbouring estate, caused great difficulties earlier in the year with the result that conscripted labour had to be employed.

" Cinchona: approximately 42 acres were harvested, the total yield being 17 tons of dry bark. Of the above area, 23 acres of *C. ledgeriana* planted in 1936-37, yielded 1,100 lbs. dry bark per acre, the stand having been reduced to 40 per cent. by *Armillaria mellea* spread from old stumps of *Grevillea robusta.* To minimise this trouble, plantations will be stumped or the standing trees ring-barked in future before planting Cinchona. All the above bark was sold to the Dar-es-Salaam totaquina factory.

" A small plot of three types of Cinchona was planted after Derris to determine whether Cinchona will thrive on the deeply-disturbed soil left after digging Derris.

" Derris: three tons of dried root were harvested from four acres planted in 1939-40, placed at two feet by two feet. Four acres of Derris were planted.

" Tung, *Aleurites montana,* and Robusta coffee gave poor results. Two tons of Tung nuts and seven tons of Robusta coffee were sold.

1944. " Cinchona: existing plantations were maintained or harvested and 17½ tons of dry bark despatched to the Totaquina factory, Dar-es-Salaam. Large nurseries were laid down and land cleared in anticipation of future developments.

" Derris: seven acres were planted, including a spacing trial, and approximately six tons of dry root harvested. Owing to lack of labour the rest of the crop was not harvested nor could cuttings be propagated for 1945 planting.

" Coffee (Robusta): only part of the crop could be harvested. Tung, *Aleurites montana:* 13 tons of fruit were harvested from 75 acres yielding 2,400 kgs. of dry shelled nuts." (A.G.H.)

During 1945 it was impossible to harvest the *Aleurites* crop owing to shortage of labour, and for the same reason the crop of Robusta coffee—such as it was—had to be abandoned on the trees.

About ten tons of dry Derris root was harvested from one plantation of 13 acres: other plantations were maintained, but harvesting was impossible owing to lack of space in the drier.

About 105 acres of various species and strains of Cinchona were planted during the year.

The re-development scheme may now be considered to have served its purpose. The Arabica coffee grafted on Robusta stocks was a complete failure. Even though well cultivated and manured it showed scarcely any improvement over Arabica growing on its own roots. The ten-acre plot

of intensely cultivated and manured Robusta coffee produced good crops, but the remainder, except for a few small areas, was disappointing. It can be definitely said that the East Usambaras are unsuitable for coffee.

Aleurites montana, after initial signs of promise on the more fertile patches of soil, did not come up to expectations. The amount of labour required for cleaning the land to enable the nuts to be picked up also militates against the economic success of this crop. Derris grows well: even on poor unmanured soil crops of nearly one ton of dry root per acre have been obtained, with a rotenone content of about nine per cent. Cinchona also shows considerable promise. All the Cinchona work at Kwamkoro has now been take over by the Cinchona Research Organisation.

Owing to the presence of tsetse fly cattle cannot be kept without constant veterinary attention and their maintenance cannot be considered an economic proposition. It has therefore been recommended that, apart from the Cinchona experiments, no further development should take place and expenditure should be limited to harvesting such of the remaining crops as will show a profit.

APPENDIX A

FINANCIAL STATEMENTS

1942

Revenue

	£	
His Majesty's (Imperial) Treasury	6,000	
Contribution Tanganyika	4,434	
,, Kenya	2,531	
,, Uganda	2,531	
,, Zanzibar	658	
,, Northern Rhodesia	1,011	
,, Nyasaland	658	
	17,823	
Local revenue (sales etc.)...	470	
		18,293

Maintenance Expenditure

Personal emoluments	10,462	
Passages	124	
Pensions contributions	1,859	
Laboratories	848	
Publications	35	
Office, telephones and contingencies	189	
Materials	257	
Freight and Transport	210	
Travelling	841	
Labour	1,625	
Provident fund bonus (including arrears)	1,493	
		17,743
SAVING		550

Summary

Reserve on 1st January, 1942	6,192	
Saving on maintenance	550	
		6,742
Capital expenditure 1942...		516
Reserve on 31st December, 1942		6,226

1943

Revenue

	£	
His Majesty's (Imperial) Treasury	6,000	
Contribution Tanganyika	5,243	
,, Kenya	3,117	
,, Uganda	2,957	
,, Zanzibar	727	
,, Northern Rhodesia	1,119	
,, Nyasaland	727	
	19,890	
Local revenue (sales etc.)...	1,477	
		21,367

Maintenance Expenditure

	£	
Personal emoluments	9,762	
Passages	28	
Pensions contributions	1,441	
Provident Fund contributions	187	
Laboratories	656	
Publications	35	
Office, telephones and contingencies	170	
Materials	410	
Freight and Transport	478	
Travelling	555	
Labour	1,857	
Loss of cash	20	
		15,599
SAVING		5,768

Summary

Reserve on 1st January, 1943	6,226	
Saving on maintenance	5,768	
		11,994
Capital expenditure 1943		402
Reserve on 31st December, 1943		11,592

1944

Revenue

	£	
His Majesty's (Imperial) Treasury	6,000	
Contribution Tanganyika	5,094	
,, Kenya	3,031	
,, Uganda	2,871	
,, Zanzibar	705	
,, Northern Rhodesia	1,084	
,, Nyasaland	705	
	19,490	
Local revenue (sales etc.)	1,425	
		20,915

Maintenance Expenditure

Personal emoluments	11,201	
Passages	762	
Pensions contributions	1,630	
Provident Fund bonus	161	
Laboratories	891	
Publications	24	
Office, telephones and contingencies	214	
Materials	420	
Freight and Transport	795	
Travelling	917	
Labour	1,778	
		18,793
SAVING		2,122

Summary

	£	
Reserve on 1st January, 1944	11,592	
Saving on maintenance	2,122	
		13,714
Capital expenditure 1944...		729
Reserve on 31st December, 1944...		12,985

Forecast for 1945 *

Revenue

	£	
His Majesty's (Imperial) Treasury	6,000	
Contribution Tanganyika	5,916	
,, Kenya	3,499	
,, Uganda	3,339	
,, Northern Rhodesia	1,168	
,, Nyasaland	822	
,, Zanzibar	822	
	21,566	
Local revenue (sales etc.)...	875	
		22,441

Maintenance Expenditure

Personal emoluments	10,319	
Passages	997	
Pensions and provident fund contributions	2,916	
Cost of living allowance	664	
Laboratories	662	
Publications	53	
Office, telephones and contingencies	232	
Materials	378	
Freight and Transport	710	
Travelling	1,000	
Labour	2,297	
		20,228
SAVING		2,213

Summary

	£	
Reserve on 1st January, 1945	12,985	
Saving on maintenance	2,213	
	15,198	
Capital expenditure 1945...	1,123	
Estimated reserve on 31st December, 1945	14,075	
The following further capital expenditure has been approved:—		
	£	
1945 Estimates	3,820	
Secretary of State 266 saving 2nd October, 1945	600	
1946 Estimates	3,200	
		7,620
Estimated net reserve free of commitments	6,455	

* *The final figures may be available from the Tanganyika Treasury about July, 1946.*

APPENDIX B

List of publications by the East African Agricultural Research Station to end of 1945.*

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1 Records of butterfly migration in East Africa. C. B. Williams, *East Afr. Uganda Nat. Hist. Soc.*, no. 35, pp. 1-16, 1929.

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7 A bark disease of coffee in East Africa. H. H. Storey, *Ann. Appl. Biol.*, vol. 19, pp. 173-184, 1932.

8 The vegetation of Mpwapwa, Tanganyika Territory. P. J. Greenway, *J. Ecol.*, vol. 21, pp. 28-43, 1933.

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11 The inheritance by an insect vector of the ability to transmit a plant virus. H. H. Storey, *Proc. Roy. Soc. London, Ser. B,* vol. 112, pp. 45-60, 1932.

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13 A note on the distribution of *Gypohierax angolensis* (Gmel.), the Vulturine Fish-eagle. R. E. Moreau, *J. Animal Ecol.*, vol. 2, pp. 179-183, 1933.

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15 A contribution to tropical African bird-ecology. R. E. Moreau, *J. Animal Ecol.*, vol. 3, pp. 41-69, 1934.

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18 Root-systems of *Coffea arabica,* Parts I and II. F. J. Nutman, *Emp. J. Exp. Agric.*, vol. I, pp. 271-284, 285-296, 1933.

19 Taxonomic and field notes on some birds of North-east Tanganyika Territory. W. L. Sclater and R. E. Moreau, *Ibis,* ser. 13, vol. 2, pp. 487-522, 656-683, 1932; ser. 13, vol. 3, pp. 1-33, 187-219, 399-440, 1933.

20 Some East African essential oils. R. R. Worsley, *Bull. Imp. Inst.*, vol. 32, pp. 253-270, 1934.

21 The insecticidal properties of some East African plants. I. R. R. Worsley, *Ann. Appl. Biol.*, vol. 21, pp. 649-669, 1934.

22 Root-systems of *Coffea arabica,* Part III. F. J. Nutman, *Emp. J. Exp. Agric.*, vol. 2, pp. 293-392, 1934.

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